Appendix B:
The Oticon Intiga Physical Design

The body of Oticon Intiga was built from the ground up as a brand new design. Since we were able to create a miniaturized version of the RISE 2 digital platform yet still maintain full wireless capability, we had the opportunity to build a RITE product significantly smaller than our current miniRITE solution (used in Agil, Acto and Ino).

The design specification did not call for simply making a hearing device smaller. The goal was to create a product that would be appealing to first-time users, yet still maintain important audiological features and also be robust for long-term use. Specifically, the following criteria were established:

- an appealing yet discreet physical design
- allow for full audiological feature set
- easy, intuitive user interaction
- supports effective directional microphone placement
- improved resiliency to moisture intrusion

The physical design and appearance of the case speaks for itself. It was chosen as the result of a structured design process in which several dozen versions were evaluated by users. Emphasis was placed on smooth, arcing surfaces. There are no buttons or switches to interrupt the look of the product. The size has been reduced by one-third compared to our miniRITE design. It is designed to tuck discreetly behind the upper part of the pinna. It sits high enough on the pinna that the front and back directional microphones are maintained in an orientation that allows for effective directivity (*Figure 14*).

The only user-operated aspect to the design is the battery drawer. To open a battery drawer that is very small compared to other RITE instruments, the user must be given some clue about where to push and pull to operate the drawer. For this requirement, the nail grip plays a major role. On one hand the nail grip should be designed so that the user is able to locate and operate the battery drawer via the nail grip intuitively. On the other hand, a big dominant nail grip would not be desirable on a small designer product. The Oticon Intiga nail grip (*Figure 15*) serves both looks and functionality. It is a smooth extension of the body's natural lines, with an obvious edge that states "pull on this spot and the door will open!"

All shell surfaces of Oticon Intiga are fully nano-coated and the electronics are sealed to protect the components from moisture. In all

Figure 14: The positioning of Intiga in place behind the pinna.

hearing instruments, however, certain parts must be exposed to the environment: the microphone openings, programming pins and battery contacts. During the development of the new shell for Oticon Intiga, certain steps were taken to minimize the opportunity for moisture to collect at these exposed elements (*Figure 16*). A top shell was included to protect the microphone inlets from direct exposure to the elements. The edges where the body faces the top shell are designed with distinct turns to minimize moisture flow into the area near the microphone ports under the top shell. Walls were built wherever possible where the body meets the top shell in order to repel sweat intrusion. Capillary traps (narrow channels that will act to attract and draw fluid away from critical components) were added to limit sweat intrusion near the programming pin and battery contacts.

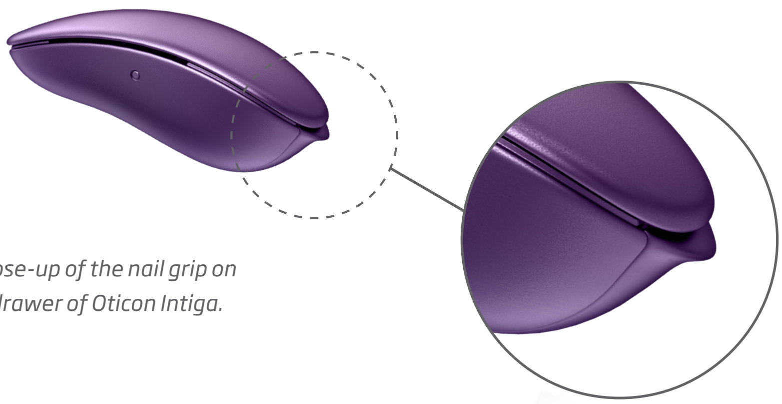


Figure 15: Close-up of the nail grip on the battery drawer of Oticon Intiga.

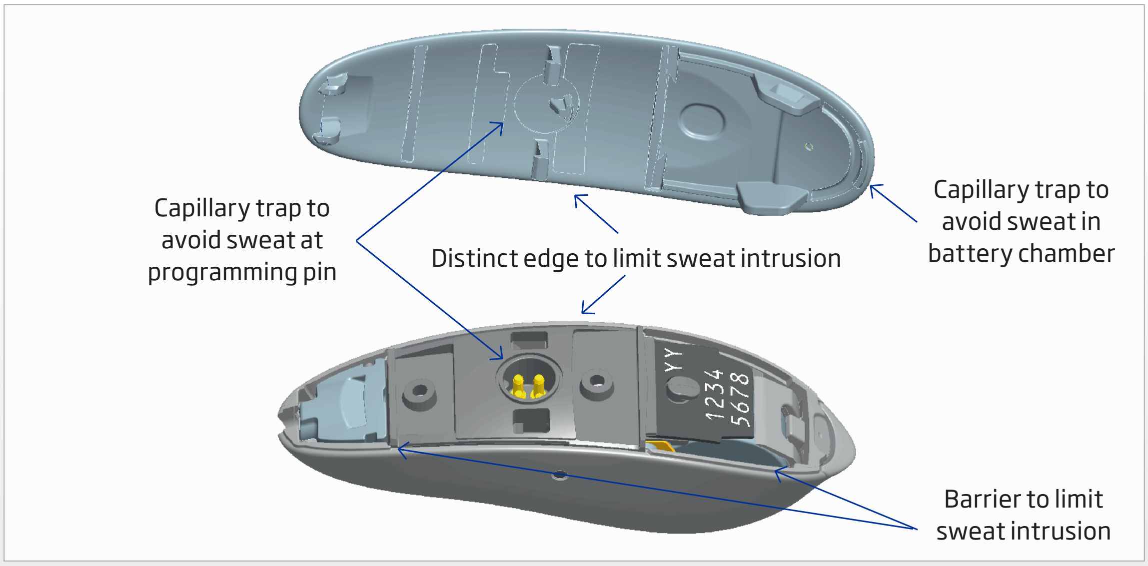


Figure 16: Shell details to limit moisture penetration.

Appendix C:

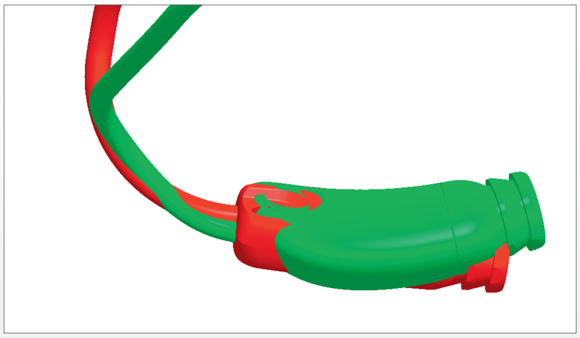
The New Speaker Design

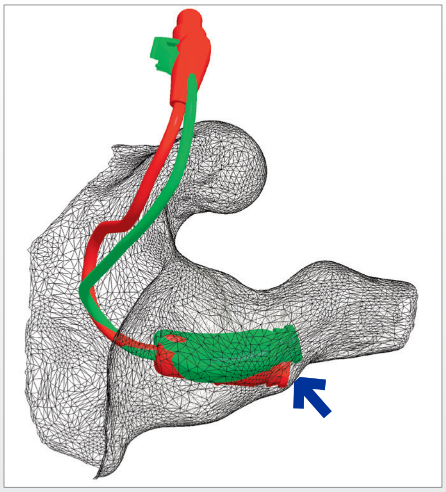
The RITE speaker unit for the Oticon Intiga has been optimized on a variety of dimensions. The goal was to create a more robust design, a more comfortable fit on the ear, better retention in the ear canal and improved sound quality, gain and output. The two most obvious changes are the curved receiver unit in the ear canal and the more pliable wire. Other improvements include a change in the type of receiver used and a change in the manner in which the speaker unit attaches to the body of the hearing aid.

Figure 17 provides comparisons between our former speaker unit (used with Agil, Acto, Ino and Dual) and the new speaker unit for Oticon Intiga. In the left panel, the 30° curvature of the new receiver is apparent when compared to the former straight design. In the middle panel, you see the advantage of the curve design in-situ. This approach reduces the likelihood that the sound will be directed into the wall of the ear canal. The 30° bend follows the natural curvature of the typical external ear canal. In the lower right corner you see a comparison of how the wire lays right outside the ear canal. In the new design the bend is sharper and the wire is pointed directly up along the side of the external ear. In the old design, there is more of a looping effect right outside the entrance to the ear canal. This natural curved design, the orientation of the wire outside the ear canal and the inclusion of a more pliable, thinner wire all allow for the receiver unit to sit more securely in the ear canal.

Figure 18 provides more details on changes in the speaker wire. The upper part of the speaker wire has been modified to optimize the curve in the final length of the wire to allow Oticon Intiga to sit naturally on top of the pinna, allowing for the proper horizontal orientation of the microphones. The middle part is straighter than in our former design. Less curvature in addition to a more pliable wire will keep the unit lying closer to the side of the head and is less likely to pull the receiver out of the ear canal. The curvature in the lower part has been modified to have a more direct path into the ear canal. Again, the sum total is to have the wire lay closer to the side of the head with less tendency to pull the receiver out of the ear canal.

Figure 19 shows a detail of how the speaker unit connects to the body of the hearing aid. The connection is crosswise in reference to the body the hearing aid. In addition, the top shell snaps in place over this receiver connection, further improving the security of the connection. If the





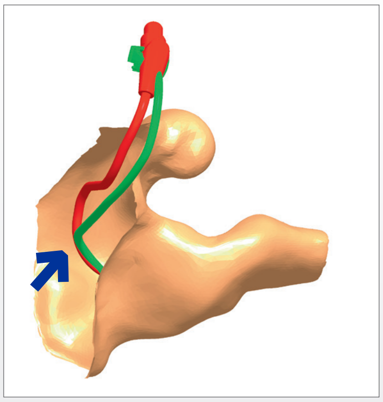


Figure 17: The new and older RITE receiver in the ear canal.

patient pulls on the wire when putting the hearing device on and off the ear, there's less tendency for the receiver to come out of place.

Within the casing of the receiver unit is a new electronic construction. A "double receiver" approach is taken. Two speaker diaphragms are placed back to back. In addition, an opening is placed in the back of the receiver. The combination of these two details allows for greater output and headroom, and a better low-frequency response, with a reduced likelihood of mechanical feedback. Additionally the electronic wiring has been improved to reduce interference with the wireless function within the hearing device itself. All these changes are accomplished without changing the overall size of the receiver unit itself. Maintaining the same size in addition to the curved housing allows a deeper and more secure fitting in the ear canal.

Appendix D:
The Adaptation Manager Update

Figure 18: The details of the shape of the new wire design.

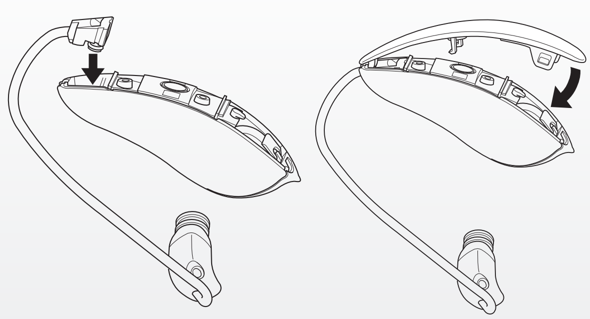


Figure 19: The details of the new connection technique for the Oticon Intiga speaker unit.

for Oticon Intiga

We originally introduced the Adaptation Manager in the late 1990s in order to help first-time users adjust to multichannel nonlinear fully automatic hearing instruments. The goal was to create an initial fitting experience that was acceptable to the patient and then transfer to a final setting that is more appropriate given the patient's hearing loss. First-time users have been struggling in certain communication situations and are looking to hear better. However, they are also used to sound at certain levels and they can react negatively if the initial experience with amplification is too overwhelming.

Our first analysis of the Adaptation Manager (Schum, 2001) indicated that, once patients made it through the adaptation process and then have the opportunity for further fine tuning, their final use settings were typically within one dB across frequency of the prescribed settings. Further, 83% of professionals who were using the Adaptation Manager were starting first-time users on Step 1. Recent follow-up work (Schum & Pogash, 2011) has indicated that presently, only 36% of professionals are consistently starting with Step 1 with first-time users. We believe that the shift represents improvements over the past decade in core signal processing, hearing device design (open RITE fittings) and compression strategies. Therefore, it was clear to us that it was due time to revisit our Adaptation Manager approach. We investigated different options for improving the settings that we use with the Adaptation Manager. We decided to specifically compare an option that rolled off the high frequencies for all input levels in order to maximize immediate acceptance to an option that decreased gain for soft and loud inputs in order to improve immediate acceptance, however increased gain for medium (speech level) inputs in the mid and high frequencies in order to improve immediate access to speech information. We included in this investigation the original Step 1. The focus of this investigation was to assess the response of first-time users on the day of the fitting. We were specifically interested in the acceptability of the fitting along with the patient's immediate ability to understand speech in noise.

As far as acceptability goes, for those patients who could hear a difference in the three options, the most commonly selected preference was for the option that boosted medium input levels but reduced soft and loud gain. Adaptive speech in noise testing indicated (*Figure* 20) best performance in noise on the day of the fitting was achieved with the option that included the boosted medium input. These results were used to make changes in Step 1 of the Adaptation Manager as applied in Oticon Intiga.

Figures 21 a through c provide a comparison of the Step 1 to Step 3 gain prescriptions for Oticon Intiga (new Step 1 settings) and Oticon Agil Pro miniRITE (original Step 1 settings) for three different audiograms that are typical of first-time users. The two most obvious changes

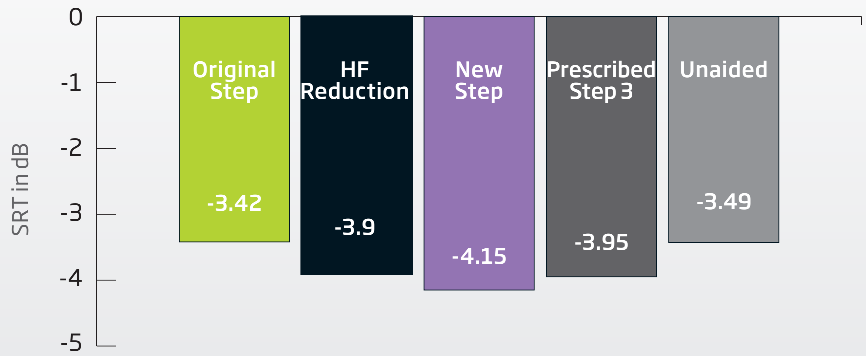


Figure 20: Speech understanding in noise for the new Step 1 settings compared to four other settings.

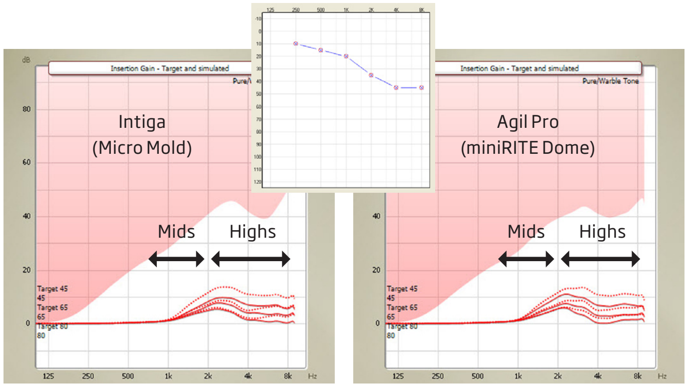
when comparing our traditional Adaptation Manager settings as indicated in Oticon Agil Pro compared with the new settings for Oticon Intiga are:

- The differences between Step 1 and Step 3 for soft inputs. The gain in the mid frequencies in the initial setting for patients wearing Oticon Intiga is significantly less.

- The differences between Step 1 and Step 3 for medium level inputs. The prescribed Step 1 gain settings in Intiga are closer to the final Step 3 settings.

Again the goal is to ensure immediate acceptance on the part of the patient but also provide access to the most important information in conversational levels of speech. By reducing gain for soft and loud inputs but also increasing gain for the important mid and high frequency region for moderate inputs, we are trying to allow the patient to hear more speech information from day one but without being annoyed or distracted by either high level inputs or by newly audible soft level room noises.

Figure 21 a: The Adaptation Manager settings for Step 1 and Step 3 for three different audiograms for Intiga on the left and Agil Pro miniRITE on the right.



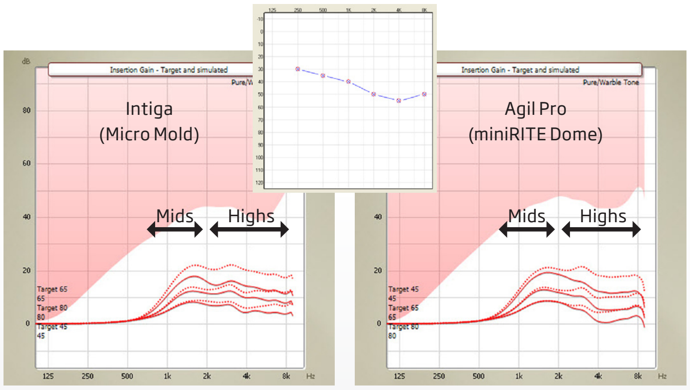
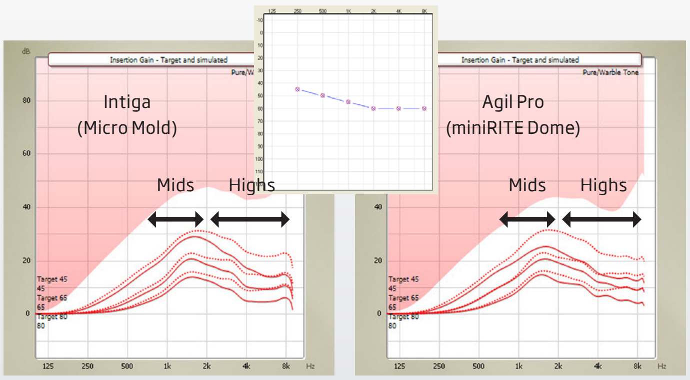


Figure 21 b: The Adaptation Manager settings for Step 1 and Step 3 for three different audiograms for Intiga on the left and Agil Pro miniRITE on the right.

Figure 21 c: The Adaptation Manager settings for Step 1 and Step 3 for three different audiograms for Intiga on the left and Agil Pro miniRITE on the right.



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